

ART. I.—*On Force.*

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THE nature of our conception of Force and of Force itself, if there be any such thing, have been the matter of frequent discussion; but the various questions raised cannot be said to have received answers which are universally accepted as satisfactory.

Why does a stone fall to the ground if unsupported? It is stated in explanation of this phenomenon that the stone is attracted by the earth, or that the earth exerts a force upon it. What do we mean in the first place by saying that a force is exerted upon the stone; and secondly, by saying that that force is exerted by the earth? Had we said that the motion of the stone was due to a force exerted by John Smith, the meaning of such a statement is plain enough—that a certain state or act of John Smith's mind, such as we call an effort, pull, or force, preceded and was the cause of the motion. Do we mean, then, in the former case, that a similar state of consciousness, a similar effort or pull, was antecedent to the motion of the stone? and if so, do we imagine the earth to be a being capable of exerting such pulls? As a matter of analytical convenience it is doubtless extremely useful to imagine inanimate bodies as exerting efforts to move each other about, similar to the forces which each man knows that he exerts himself, and which he believes to be exerted by other human beings; but do they really do so? I follow the system of philosophy which Mr. G. H. Lewes is now expounding, so far at all events as to reply that we have no means of ascertaining whether they really do or not; that the idea of forces supposed to be exerted by inanimate bodies is a metempirical concept, indispensable perhaps for purposes of calculation, but resembling subsidiary unknowns introduced in the course of solving a mathematical problem, which disappear in the final result.

The effects of which the forces are supposed to be the

causes are all we are concerned with, and whether the earth really exerts a pull on the stone or not is a question which neither common sense nor science can solve, nor, in my opinion, need desire to solve; let the metaphysician undertake the impossible and unprofitable task if he will.

The answers I have given to the above questions concerning Force would probably be accepted by all disciples of the modern Experience school of philosophy, but many able investigators of nature and powerful reasoners have not been content with the bounds which it sets to the kingdom of knowledge. Thus Sir John Herschel has said—and his dictum is quoted with approval in a very clever and eloquent article by the late Mr. Martineau (*Contemporary Review*, March, 1876), which has important bearings on the question at issue:—

“It is our own immediate consciousness of effort when we exert force to put matter in motion, or to oppose and neutralise force, which gives us this internal conviction of *power* and *causation* so far as it refers to the material world, and compels us to believe that whenever we see material objects put in motion from a state of rest, or deflected from their rectilinear paths, and changed in their velocities if already in motion, it is a consequence of such an *effort somehow* exerted, though not accompanied with *our* consciousness.”

Mr. Martineau also quotes Du Bois-Reymond, a philosopher of a very different way of thinking, who says:—

“Power, regarded as the cause of motion, is nothing but a more recondite product of the irresistible tendency to personify which is impressed upon us. What do we gain by saying that it is reciprocal Attraction whereby two particles of matter approach each other? Not the shadow of any insight into the nature of the process.”

And Mr. Martineau is forced to admit that Du Bois-Reymond is justified in his criticism if the human mind has nothing to do but to become an accomplished *Naturforscher*; which is, I presume, the only aim of the human mind which Physical Science is concerned with.

The question under discussion may be not unprofitably illustrated by an analogy from the undulatory theory of light. As that theory is commonly taught in the textbooks, it supposes that at each point of space through which light is being propagated there goes on a backward

and forward motion of particles analogous to the vibrations of a pianoforte-wire, and to students, nay, even to expert physicists, it is doubtless a great assistance to have the hypothesis stated in that concrete and specific form. But the truth of the undulatory theory is only established by the agreement of its results with those of experiments, and the same results could be obtained from a much more general hypothesis than that usually made. It is only necessary to suppose that, as Clerk Maxwell says (*Electricity and Magnetism*, Vol. II., p. 407), the disturbance which constitutes light is of the nature of a vector (*i.e.*, a quantity having both magnitude and direction) perpendicular to the ray; and all the beautiful theorems whose truth has been so abundantly confirmed by experiment and observation, could still be deduced if we supposed that the vector disturbance is a strain, a rotation, a magnetisation, or electrification of particles, instead of supposing the particles to have motions of translation.

Still it would be inconvenient, if not impossible, especially for purposes of instruction, to abandon the ordinary specific hypothesis. In the same manner should the hypothesis of forces exerted by inanimate bodies be maintained, as though not necessarily true, still very convenient, and invariably leading to true results. It is often said that if all calculated results of an hypothesis agree with experiment, that hypothesis must itself be true. The statement is not correct. The most that we are warranted in believing is that all other calculated results will also be found to be experimentally true, and this is especially the case when the hypothesis is one like that of Forces, which from its very nature cannot and could not under any conceivable circumstances be directly subjected to an experimental test. Surely it is more hopeless to attempt to verify the existence of the earth's attraction than it is to endeavour to see the vibrations of the ether.

Professor Tait, in a lecture delivered before the British Association last year, has attacked the existence of Force in a different manner; and although I agree so far with his conclusions as to believe that the existence of material forces is not and cannot be proved, I do not believe the reasoning by which he arrives at that conclusion is valid. He not only believes that Force is proved not to have real objective existence, but that that peculiar and abstruse

quality is proved to be possessed by Matter and by Energy. One of the premises from which he is led to his conclusions is that Matter and Energy are unalterable in quantity, while Force is not so. True enough; but consider the other premise—that those qualities or entities whose total quantity is unalterable, and those only, do really exist.

By anything having real objective existence, Professor Tait explains that he means that it exists altogether independently of the senses and brain processes, by which we are informed of its presence. Whether anything does exist in this independence, I do not know; nor do I believe that any one else does or can. But without going into the controversy between Realism and Idealism, I simply ask whence does Professor Tait obtain his axiom connecting absolute reality and indestructibility? What higher claim has it to credence than any of the axioms criticised by Mill, in his chapter on Fallacies of Simple Inspection, such as “Circular motion is the most perfect,” “Things which we cannot think of together cannot coexist,” “Things which we cannot help thinking of together must coexist,” “Whatever can be thought of apart exists apart,” and so on?

Moreover, if the negative portion of the axiom be accepted, although Matter—that is Mass—is proved to exist, Time, Distance, Motion, are degraded to the rank of nonentities along with Force.

But how is the mass of a body defined and measured? By the effect which a certain *force* acting on the body for a certain *time* would produce. And how is energy defined and measured? As power of doing work—that is, of overcoming a given *force* through a certain *distance*. Surely I cannot be accused of presumption in criticising the conclusions of a thinker of Professor Tait's high standard when he tells us that that which is defined in terms of, and measured by means of, that which does not exist, has itself independent real existence.

As probably most of you have read the lecture referred to, it is unnecessary for me to say anything about the most valuable part of it—Professor Tait's exposition of the loose and ambiguous way in which the term Force is often used even by those who should know better. For this he should have earned the gratitude of all lovers of that accuracy in scientific language without which accuracy of thought is almost unattainable.